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OBITUARY.

With deep regret we have to record the death of Inche Uda bin Samsudin, Junior Agricultural Assistant, Kuantan, which occurred in Kuantan on the 3rd March, 1927.

On leaving the Malay College, Kuala Kangsar, Inche Uda was appointed a Laboratory Attendant in the Chemical Division of this Department, on 19th February, 1913. Later he served both in the Botanical and Field Divisions, in the former assisting for five seasons in the work of padi-selection at the Titi Serong Padi Experiment Station. At the time of his death, Inche Uda had been a Junior Agricultural Assistant for several years and had qualified for promotion to Senior Agricultural Assistant.

By his death this Department loses an officer, valued for his intelligence, hard work, reliability and tact. Throughout his fourteen years in the Department, he used every opportunity to improve his knowldge of matters pertaining to his profession, so that he might the better advance the true interests of his countrymen to whom he set an excellent example of diligent and willing service.

His pleasant personality and keen interest in his work won the affectionate esteem and confidence of his fellow-officers in the Department who deeply sympathise with his wife, son and relatives in their bereavement.

JELUTONG.

B. J. Eaton, C. D. V. Georgi and Gunn Lay Teik.

Introductory.

An account was given in a previous number of this Journal, Vol. XIV, 1926, No. 9, page 275 of an investigation carried out with jelutong latex using various coagulants in order to ascertain the most satisfactory method of coagulation having regard to the minimum amount of coagulant.

As a result of these experiments acetic acid was recommended as a coagulant, the amount of acid required for satisfactory coagulation being 1 part to 2000 parts of latex. The normal period of coagulation is approximately 3 days

The latex collected daily from the trees being tapped experimentally in the Weld Hill Forest Reserve was treated by this method with satisfactory results, the jelutong being sold to the local representatives of American buyers.

With the arrival of the wet season however the phenomenon of partial coagulation, which had been noticed previously, became more evident, although the period of coagulation was increased to 4 and even 5 days. Further experiments were therefore made and another method of coagulation, based on heating the acidified latex, was investigated. The new method has been applied successfully to latex from the same source since the commencement of the year and in spite of wet days satisfactory coagulation has always been obtained.

The question of the deterioration of jelutong has also been investigated and a series of experiments carried out on the treatment of the coagulum which is necessary to preserve the product during storage and transit.

Composition of Latex.

The method of coagulating the latex by boiling after the addition of a small quantity of acetic acid and the work on the preservation of jelutong have rendered necessary an investigation on the more important constituents of the latex. Although this consisted only of a general analysis the results are recorded here in view of their significance in connection with some of the changes which are observed.

Jelutong latex when freshly collected has a *p*H value of approximately 7.0 (neutral); acidity develops on standing, the *p*H value being reduced to approximately 5.5 after 24 hours, and, if no appreciable amount of coagulation has taken place after 48 hours, it will be found that the *p*H value has been reduced to approximately 5.0.

The following table shows the result of analysis of an average sample of latex. In all cases the figures recorded are the average of duplicate determinations.

		per cent.
Total Solids (dried at 100°C)	...	19.87
Total Solids (on ignition)	...	0.03
Solids coagulated by Alcohol	...	15.54
Nitrogen (Kjehldahl)	...	0.025

A qualitative analysis of the residue left on ignition showed the presence of varying quantities of calcium, magnesium, potassium, sodium, phosphate and carbonate.

It is interesting to note the very low nitrogen content of the latex as determined by the Kjehldahl method. Although it is known that certain compounds of nitrogen present in Hevea latex are not determined by the Kjehldahl method, it is considered that the above figure may be regarded as an approximate measure of the nitrogen content of the latex.

In the paper referred to above it was pointed out that the amount of total solids obtained by evaporation is between 20 and 25 per cent. greater than the amount of the solids coagulated by alcohol and that the excess solids are chiefly organic. The figures in the above table confirm this, the actual excess in the present instance amounting to 28 per cent.

An approximate analysis was made of these solids, as a result of which it is possible to suggest an explanation for one particular type of deterioration of the product viz. the development of a black mould.

When the clear serum, remaining after coagulation of the latex with alcohol, is concentrated, the liquid becomes turbid and eventually a small quantity of a white flocculent precipitate is formed. If this is filtered, the filtrate can be evaporated to dryness without the formation of any further precipitate. A dark brown hygroscopic crystalline mass, possessing a smell of caramel, is obtained.

This material is readily soluble in cold water. The solution is slightly dextro-rotatory, the specific rotation at 28°C being approximately +2.6°. The solution has a strong reducing action on Fehling's solution, indicating the presence of sugars. There is no increase in the reducing action on Fehling's solution after inversion.

The dry material gives a residue of approximately 0.5 per cent. on ignition.

The nitrogen (Kjehldahl) content of the material is very low, being approximately 0.07 per cent, calculated on the dry material.

It was not possible to carry out many experiments with the flocculent precipitate, formed on concentration of the serum, on account of the small quantity available, which amounts to only 0.1 per cent, calculated on the original latex. The nitrogen content of this material is also low, amounting to 0.6 per cent. The residue left on ignition amounts to 0.7 per cent.

From these results therefore it is interesting to note the presence in the latex of a large proportion of gummy material and sugars, which remain in the serum after coagulation. The presence of the sugars is liable to cause bacterial changes in any material with which they may be associated.

Experiments on Coagulation.

(a) *Coagulation by heating.*—On boiling fresh latex (pH 7.0) coagulation takes place to a certain extent, the amount of dry coagulum being about 50 per cent. of that obtained by coagulation with alcohol. If the latex is kept for one day and no coagulation, other than the formation of a thin skin on the surface, has taken place during this period, the pH value decreasing to about 5.0, satisfactory coagulation can be effected on boiling the latex.

It was ascertained that satisfactory coagulation could also be effected, if the fresh latex were acidified to the same pH value (5.0) with acetic acid, and the liquid boiled for a few minutes. The amount of acid required is very small, only 0.01 grammes of acetic acid per 100 ccs. of latex, equivalent to 0.16 fluid ounces of acid per gallon of latex.

It is interesting to note that this method will not give satisfactory results, if coagulation to any extent has taken place previous to adding the acid, even though the concentration of the acid is increased considerably.

These experiments, based on volume measurements of the latex, showed that the amount of dry jelutong obtained by this method is slightly in excess of that obtained with alcohol, but, in order to obtain a more exact relationship between the two methods, it was decided to treat weighed amounts of latex by both methods. The following results were obtained with latex collected on different days. The amounts obtained by the heat coagulation method were 100.6, 101.1, 100.7, an average of 100.8, compared with 100 per cent by alcohol coagulation.

In view of the small amount of acid required in the above process of coagulation it was considered desirable to investigate the effect of the addition of larger amounts of acid. The results of these experiments are given in Table I below:—

TABLE I.

Results of Experiments with Increasing Amounts of Acetic Acid.

Parts of acid per 100 parts of Latex.	Percentage coagulation.
0.01	100.0
0.02	99.3
0.04	93.5
0.06	86.3
0.08	73.0

The results of the above experiments show that, with an increasing amount of acid, there is a corresponding decrease in the percentage of coagulation, indicating the importance of adhering to the amount of acid recommended.

Further the addition of an excess of acid increases the tendency of the liquid to froth when boiled.

Since it is well known that the dry jelutong content of the latex is liable to variation, it was considered advisable to make a series of experiments with latex diluted with water in varying proportions in order to ascertain the maximum dilution possible without inhibition of coagulation. The results of this series of experiments are given in Table II. The dry jelutong content of the latex used was approximately 15.8 parts by weight per 100 parts of latex.

TABLE II.

Results of Dilution Experiments.

Parts by weight of latex.	Parts by weight of water.	Percentage coagulation.
100	—	100
90	10	98.8
80	20	99.4
70	30	99.6
60	40	96.5
50	50	82.4
40	60	47.1
30	70	35.1
20	80	22.1
10	90	33.5
—	100	—

From these results it will be seen that it is possible to dilute the latex with one third of its volume of water before any appreciable reduction in coagulation occurs.

This method therefore appears preferable to that of treating the latex with the requisite amount of coagulant and allowing to stand for 3 days. In the case of the latter method there is always uncertainty as to the extent of coagulation, but with the method described above satisfactory coagulation is a certainty.

It is considered that the extra yield of jelutong will more than compensate the producer for the quantity of fuel required to boil the latex, in addition to which it is possible to complete the preparation of the material on the day on which the latex is collected.

With regard to the details of coagulation it has been found convenient to use 4 gallon kerosine tins for the treatment of the latex, not more than 3 gallons of latex per tin being treated, owing to the tendency of the liquid to froth when boiled. It is advisable to stir the liquid frequently during heating, otherwise the coagulum may adhere to the inside of the tin and become overheated. The liquid should be maintained in a state of ebullition for at least 3 minutes, in order to ensure that latex occluded in the coagulum is also coagulated. When coagulation is complete, the coagulum is withdrawn, and the serum allowed to drain away, the lump being kneaded with a wooden batten in order to squeeze out as much as possible of the liquid. The subsequent treatment of the coagulum will be described later.

It may be mentioned here that the serum is slightly turbid and yellowish in colour, but experiments have shown that the amount of remaining material coagulated by alcohol is negligible, amounting approximately to 0.1 parts per 100 parts of the original latex.

(b) *Coagulation with Formic Acid.*—A series of experiments has been carried out with formic acid in view of the increased interest being taken in the use of this acid as a coagulant for Hevea latex, compare Malayan Agricultural Journal, Vol. XIII, 1925, No. 8. page 273.

It was found that approximately half the quantity of formic acid, as compared with acetic acid, is required for satisfactory coagulation. Thus, with a concentration of 0.03 parts of formic acid per 100 parts of latex, coagulation to the extent of 91 per cent, compared with alcohol coagulation as standard, was obtained after 3 days, and repeat experiments, using 0.025 and 0.02 parts of acid per 100 parts of latex, after a similar period gave coagulations of 95 per cent and 90 per cent respectively.

(c) *Coagulation with Sulphuric Acid.*—In connection with the problem of deterioration experiments were carried out with sulphuric acid as a coagulant. It was found that the quantity required to effect satisfactory coagulation is approximately 0.02 parts of acid per 100 parts of latex. The following percentage coagulations, compared with alcohol coagulation as standard, were obtained after a period of 3 days, 92 per cent. with 0.015 parts, 88 per cent. with 0.02 parts and 90.5 per cent with 0.025 parts of acid respectively per 100 parts of latex. These amounts were confirmed by repeat experiments.

(d) *Coagulation with Potash Alum.*—Similar experiments were carried out with potash alum, satisfactory results being obtained with 0.05 parts of the alum per 100 parts of latex.

It is interesting to note that with an increase in concentration of this coagulant there is a progressive decrease in coagulation until, with a concentration of 0.14 parts to 100 parts of latex, there is no coagulation after a period of 3 days. In this respect it will be observed that potash alum resembles sodium silicofluoride.

It is desired to point out that the only object of the experiments with sulphuric acid and potash alum was to determine the minimum quantity of these coagulants necessary for satisfactory coagulation, in order that sample blocks of jelutong could be prepared for certain preservation experiments. The writers have no intention of changing their opinion regarding the undesirability of recommending either of these coagulants for general use, although there is evidence that they are still being employed in some parts of the country.

Deterioration and Preservation of Jelutong.

An investigation on this subject has been carried out previously in this Department, compare "Further Studies in Jelutong" by V. R. Greenstreet, Malayan Agricultural Journal, Vol. XIII, 1925, No. 1, page 1. and, before giving an account of the work carried out recently, it is considered advisable to recapitulate some of the results recorded in that paper.

Freshly coagulated jelutong is white in colour and possesses a fine honeycomb structure. The material is slightly tough, although it can be broken easily by hand. If a portion of fresh coagulum be pressed a plastic lump is formed, the surface of which hardens on exposure to air.

The fresh unpressed coagulum has a high moisture content, between 70 and 80 per cent; the greater part of this can be removed by pressing or rolling the material to a thin sheet. It must be pointed out that it is not possible to reduce the moisture content of the material to a low limit, as in the case of rubber, jelutong retaining moisture very tenaciously.

If jelutong be warmed it loses its original structure and becomes soft and plastic owing to the softening of the resins but, on cooling, the material hardens again.

In the use of jelutong for the preparation of chewing gum and other confectionery it is essential that the material shall be plastic, so that it can be incorporated with the other ingredients. The object of all preservation therefore must be to maintain the material in this state until it is required for use by the manufacturer.

Jelutong is liable to deterioration, evident either by the complete drying out of the material to a brittle mass, which has a strong resinous odour, or by the development of a black fungus which penetrates the material and results in a transformation of the interior of the block into a brownish black semi-liquid mass, possessing a curious mouldy odour.

It may be mentioned here that, in addition to the black mould, the surfaces of freshly prepared jelutong blocks are liable to develop various coloured spots, chiefly pink, but these spots do not persist for any length of time.

Although several sample blocks of jelutong of varying moisture content have been prepared and kept for periods from 6 to 9 months the deterioration due to drying out has not been observed; in all cases the deterioration which has occurred has been due to the penetration of the black mould.

Since all these samples were prepared by treating the latex with acetic acid, it was thought that the presence of the black mould might be associated with the use of this coagulant. In order to investigate these points further sample blocks of Jelutong have been prepared with different coagulants and these blocks will be examined from time to time to note any deterioration due to the presence of the black mould or conversion to a brittle mass.

Jelutong can be preserved for long periods, up to one year, under water without being affected, except for a slight increase in the moisture content, which depends both on the period of immersion and the original moisture content of the material.

It was noticed that a block of jelutong made by pressing together pieces of creped material invariably showed signs of deterioration in the interstices between the layers. When preparing blocks of the material it would appear advisable therefore to preserve an unbroken outside surface, so that in the event of the formation of moulds on the surface it will be more difficult for them to penetrate.

Although no attempt has been made to identify the black fungus it appears probable that its development can be attributed to the presence in solution in the block of a relatively large amount of organic material, containing a fair proportion of sugars If therefore conditions for fungoid development are made less favourable by eliminating the greater proportion of this soluble material, then it should be possible to prevent such deterioration.

The usual method employed to reduce the soluble matter is to boil the coagulum with a large quantity of water and then to transfer the mass to a second vessel containing a further quantity of boiling water, to which has been added a small amount of soap oil emulsion. During the process of boiling in the second vessel the jelutong absorbs the oil, which is incorporated when the mass is subsequently shaped into a block. The presence of the oil is said to have a retarding action on the rate of loss of moisture from the block, at the same time excluding air.

It would appear however to be of much greater importance to knead the jelutong thoroughly before pressing in order to ensure the formation of an impervious skin, which acts as a protective layer.

The soap oil emulsion is made by shaking together an aqueous soap solution of approximately 5 per cent strength with a special white Kerosine oil, until no more of the latter can be absorbed by the emulsion.

A mixture of castor oil and ammonia can be used similarly to the soap oil emulsion, but the latter is preferable, on account of the tendency of the castor oil and ammonia to cause the development of an unpleasant odour.

The results of a series of experiments carried out by employing the various methods described above are shown in Table III. In all cases the amount of acetic acid used for coagulation was 0.05 parts of acid per 100 parts of latex.

Although it will be noticed that, in some of the experiments, the latex was treated with formalin, the addition of this substance as a preservative is not recommended, in view of its inhibiting effect on coagulation.

TABLE III.

RESULTS OF PRESERVATION EXPERIMENTS BY BOILING WITH WATER AND TREATING WITH SOAP OIL EMULSION.

Sample No.	Method of Preparation of sample.	Moisture content of fresh sample. (per cent).	Moisture content of sample after 6 months (per cent)	Condition of sample after 6 months
1	Latex treated with 0.16 parts of formalin per 100 parts of latex and coagulated with acetic acid. Coagulum boiled with water, treated with soap oil emulsion and pressed into block ...	38.7	0.6	Satisfactory.
2	Latex treated with 0.16 parts of formalin per 100 parts of latex and coagulated with acetic acid. Coagulum boiled with water and pressed into block ...	36.1	0.6	Satisfactory.
3	Latex treated with 0.08 parts of formalin per 100 parts of latex and coagulated with acetic acid. Coagulum boiled with water and pressed into block ...	31.7	0.6	Satisfactory.
4	Latex treated with 0.08 parts of formalin per 100 parts of latex and coagulated with acetic acid. Coagulum boiled with water, treated with soap oil emulsion and pressed into block ...	37.1	1.4	Satisfactory.
5	Latex coagulated with acetic acid. Coagulum boiled with water, treated with soap oil emulsion and pressed into block ...	33.5	2.1	Satisfactory.
6	Latex coagulated with acetic acid. Coagulum boiled with water, treated with soap oil emulsion and pressed into block ...	32.9	0.3	Satisfactory.
7	Latex coagulated with acetic acid. Coagulum boiled with water and pressed into block ...	32.5	1.0	Satisfactory.

In connection with the above experiments it may be mentioned that the blocks were subjected to a more severe test than usual, since, when determining the moisture content of the fresh block, it was necessary to divide it into two parts, and the part kept for 6 months had the cut portion exposed to the air.

Although the moisture contents of all samples after 6 months were so low it was still possible to pass them through a crepeing machine and, on immersion in warm water, all the samples were plastic.

From these experiments therefore it is interesting to note that it is possible to preserve the material satisfactorily provided that it has been boiled with a large excess of water, thereby reducing the water soluble serum solids to a minimum. It would appear unnecessary to treat with soap oil emulsion, but further experiments are being undertaken to decide this point.

Another method, which has been suggested for the preservation of jelutong and for which a patent has been applied, consists in drying the washed jelutong by heating to a temperature of about 100°C, and then pressing the product into blocks.

It is well known that pieces of the creped material, such as are obtained when carrying out the determination of the moisture content of jelutong and which have been dried to constant weight in the steam oven, can be preserved for a long period without showing any signs of deterioration, other than a slight darkening of the surface. This discolouration would appear to be of little consequence to the manufacturer.

It is considered doubtful whether such a method would be of any practical value on a large scale in view of the expense involved in the provision of the necessary plant and the fuel required for the prolonged heating necessary to eliminate the moisture. It must be admitted however that there would be a considerable saving in transport charges consequent upon the elimination of such a large amount of moisture.

Properties of Jelutong.

If dry jelutong is extracted with acetone the material can be separated into two portions, the soluble portion amounting to approximately 80 per cent, consisting of resinous material, while the insoluble portion resembles caoutchouc.

Although no attempt has been made to determine the composition of either the resins or the caoutchouc, the results obtained by Greenstreet in the paper referred to above have

been confirmed. It has been found that, where deterioration due to drying has occurred, the material becomes completely soluble in acetone, indicating that the caoutchouc portion has been changed.

Analyses of samples of jelutong, which have undergone no deterioration, show no increase in their acetone soluble content.

Experiments were carried out to ascertain whether the acetone soluble content of jelutong varied with the extent of coagulation. Similar quantities of latex were treated with the same amount of coagulant and the coagula withdrawn after varying periods. The results however were inconclusive.

As a result of these experiments it was observed that there were considerable variations in the amount of the acetone soluble content in jelutong prepared from latex collected from the same trees on different days, indicating considerable variation in the composition of the latex.

The dry product yields only a very small residue on ignition, amounting to 0.25 per cent.

The nitrogen content is also low, amounting to only 0.12 per cent, calculated on the dry material.

Preparation and Marketing of Jelutong.

As a result of the various experiments carried out on the coagulation of the latex and the deterioration of the prepared jelutong it has been found possible to adopt a formula, for the preparation of jelutong on a commercial scale. This formula, which is given below, has been tested on latex collected daily from the Weld Hill Forest Reserve with satisfactory results and favourable reports on the product have been received from the American buyers.

The latex is strained through a fine wire sieve to remove debris and is then measured out in 3 gallon lots into kerosine tins. The requisite amount of acetic acid is then added, viz. half a fluid ounce of a 10 per cent. solution for 3 gallons of latex. The tin is covered with a loose lid, and the contents brought to the boil, the liquid being stirred constantly during this operation. Boiling is maintained for about 3 minutes, when the contents of the tin are transferred to a bamboo sieve and, after the excess serum has drained away, the lump of coagulum is pressed on the sieve with a wooden batten in order to squeeze out as much as possible of the remainder.

The coagulum is then transferred to a large circular

iron pan half filled with water and boiled for about 10 minutes, the lump being turned over frequently in order to expose fresh portions to the action of the boiling water. The material is then withdrawn and kneaded with a plank on a wooden board in order to reduce the quantity of water in the lump and at the same time to form an impervious skin on the surface. The lump is then shaped to the size of the press, and, after pressing, is rinsed with water and allowed to dry.

The quantity of latex (3 gallons) recommended above produces a block weighing about 8lbs, the amount found convenient for the press employed. The internal dimensions of the press are 12 inches x 5 inches x 5 inches.

A wooden press is preferable since it prevents discolouration of the surface of the block and also on account of the fact that occasionally the jelutong has a tendency to adhere to the sides of an iron press. When using a wooden press it is advisable to wet the inside surfaces to avoid adhesion of the material.

In treating large quantities of jelutong it is essential to boil in large tanks or pans, changing the water frequently to avoid the accumulation of the soluble serum solids.

It will be observed that no mention has been made of the original method of coagulation, by adding the requisite amount of coagulant and allowing the latex to stand for 3 or 4 days. This method has been abandoned in view of the difficulty experienced with partial coagulation.

If it is desired to treat the jelutong with the soap oil emulsion the latter can be added to the boiling water in the proportion of 1½ fluid ounces to 8 lbs of the finished product.

As explained previously, the emulsion is prepared by making a 5 per cent. solution of soap (Castile soap preferably) in water and adding the oil gradually with constant shaking until no more oil can be absorbed. It will be found that a given volume of soap solution can absorb approximately half its volume of oil.

In native practice the soap oil emulsion is prepared by using ordinary kerosine oil. A purified kerosine oil known as Technical White No. 95, prepared by the Standard Oil Company of New York, and recommended by Mr. S. S. Yates of the Chicle Development Company, New York is however preferable, owing to absence of odour in the finished product. This oil has been used in our experiments. Other special White Kerosine Oils prepared by oil refiners are also suitable.

The jelutong blocks may be kept under water until required for packing. It is probably advantageous to store

the product in this way in order to reduce as much as possible the amount of water soluble organic material contained in the surface layers. The proportion of water which may be absorbed is of little or no consequence.

With this method of preparation jelutong contains approximately 45 per cent. of moisture. This amount is the standard percentage of moisture on which the material is bought, a premium being paid for any lower moisture content, and a corresponding reduction made for an excess of moisture.

It is considered that this amount of moisture is somewhat excessive and attempts were made to reduce it by passing the jelutong through crepeing rollers, folding the crepe into the shape of the block, warming for a few minutes by immersion in hot water and then pressing again. The reduction in moisture content however is only about 10 per cent. and, in view of the extra work and expense involved. the treatment has been discontinued.

Summary.

(1) This article deals with a new method for coagulating jelutong latex, which overcomes the disadvantages of delayed and partial coagulation of the method recommended previously.

(2) The problem of one type of deterioration of jelutong is discussed and a method of treatment for preservation is described.

In conclusion the writers wish to record their appreciation of the assistance afforded by the representatives in Singapore of L. A. Dreyfus and Co., New York. It was through a suggestion made by Mr. H. Straetz of that firm that the new method of coagulation which has given such satisfactory results was investigated.

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Dry Rubber Content of Hevea Latex from Trees in Clean Weeded Areas and in Areas Under Fern Growth.

F. G. Spring.

Observations have been made in order to determine whether a cover of ferns has any influence on the dry rubber content of latex from trees growing in such conditions. Only a few records were taken but they indicate that the dry rubber content of latex from trees of similar age growing in clean weeded areas and a cover of ferns is similar. It is recognised, however, that insufficient records were made to arrive at definite conclusions yet they are of sufficient interest to warrant their publication.

Each sample of 250 c. c. was taken just before field collection and consisted of a mixture of latex from a group of average type of trees. The system of tapping and position of cut on the trees were the same in the fern areas as in the clean weeded fields. The latex was coagulated in the field with acetic acid and afterwards taken by the writer to the offices of the Department of Agriculture, F.M.S. and S.S. where the coagulum was manufactured into fine crepe rubber which was thoroughly dried and weighed.

Estate A.—The land on which the records were made was planted up with rubber in the year 1917, at distances of 20 ft. by 20 ft. The land is undulating and hilly and the soil a sandy loam. The trees are in excellent condition. Tapping was commenced on the 1st of February, 1926, at a height of 26″ from the ground, the system being a single V cut on half the circumference, alternate day tapping. The land has been under a cover of ferns for several years, the ferns being cut back once a year. The clean weeded area is also 1917 planting, the soil conditions, system of tapping, position of cuts, etc., being similar to those of the fern area.

Estate B.—The rubber was planted in the year 1917, at distances of 20 ft. by 20 ft. on undulating and hilly land. The soil is a rich sandy loam. The system of tapping is a single V cut on half the circumference, alternate day. Ferns have been grown for the past five years and consist of Gleichenia linearis (fern with forked leaves, known in Malaya as Beng Kawang or Paku Ribu), Pteris aquilina and Nepherolepis exaltata. The rubber trees are well grown and in excellent condition. The clean weeded area has equal aged trees and similar conditions to the fern area.

Estate C.—This rubber was planted in the year 1909, at distances of 15 ft. by 15 ft. The land is undulating and hilly and the soil a light friable clay loam. The ground was under coffee and pepper cultivation previous

to the growing of rubber. The system of tapping is a half spiral cut, alternate day. The land has been under staghorn moss (Lycopodium) for about four years. The clean weeded field has similar conditions to that of the fern area.

The results of dry rubber content of the latex samples taken from estates A.B. and C. are given in the attached table.

The following are records of the dry rubber content of latex obtained from trees on five estates which have been under a cover of ferns for several years. Each sample consisted of a mixture of latex from a group of trees, the selected trees had the position of the cut about one ft. from the ground.

Estate.	Age of tree. years.	Volume of latex C.C.	Wt. of dry rubber in grms.	Dry rubber Content %
1	6	200	49	24.5
2	7	200	60	30.0
3	8	200	65	32.5
4	10	200	74.5	37.2
5	13	200	70.5	35.2

The following are readings of the dry rubber content of latex obtained from several old rubber estates under clean weeded conditions. Each sample consisted of a mixture of latex all obtained from fairly low cuts from a group of trees. All readings were made about the same hour of the day.

Age of Trees. years.	Estate.	Volume c.c.	Wt. of dry rubber in grms.	Dry rubber content %	Date.
20	1	200	67	33.5	30.12. 25
...	„	200	77	38.5	1. 2. 26
...	„	200	74	37.0	2. 2. 26
...	„	200	75	37.5	3. 2. 26

Age of Trees. years.	Estate.	Volume c. c.	Wt. of dry rubber in grms.	Dry rubber content %	Date.
...	1	200	78	39.0	4. 2. 26
...	,,	200	75	37.5	5. 2. 26
...	,,	200	74	37.0	6. 2. 26
...	,,	200	72	36.0	8. 2. 26
...	,,	200	72	36.0	9. 2. 26
...	,,	200	75	37.5	10 2. 26
...	,,	200	66	33.0	11. 2. 26
...	,,	200	74	37.0	20. 2. 26
...	,,	200	83	41.5	9. 3. 26
23	2	615	220	35.7	26. 6. 26
...	,,	1000	350	35.0	26. 6. 26
...	,,	320	114	35.6	26. 6. 26
24	3	200	73	36.5	29.12. 25
24	4	925	331	35.7	24. 2. 26
...	,,	414	177	42.7	24. 2. 26
...	,,	584	235	40.2	24. 2. 26
25	5	990	290	29.3	29. 6. 26
...	,,	696	235	33.7	29. 6. 26
...	,,	756	271	35.8	29. 6. 26
...	,,	100	36	36.0	29. 6. 26
25	6	360	134	37.2	24. 6. 26
...	,,	282	100	35.4	24. 6. 26
...	,,	519	196	37.7	24. 6. 26
27	7	468	183	39.1	21.10. 26
...	,,	396	142	35.8	21.10. 26
29	8	593	203	34.2	22. 2. 26
29	9	846	321	37.9	30. 6. 26
...	,,	762	292	38.3	30. 6. 26
...	,,	1060	391	36.8	30. 6. 26
29	10	925	331	35.7	24. 2. 26
...	,,	414	177	42.7	24. 2. 26
...	,,	584	235	40.2	24. 2 .26

Note—The dry rubber content is expressed in grms per 100 c. c. of latex.

Estate A.

The Volume of latex was recorded on the 26th. November, 1926.

| | | |

Hastening the Germination of Oil Palm Seeds.

J. N. Milsum.

In the early days of oil palm cultivation in the East Indies, a serious difficulty was frequently experienced in the slow and often unreliable germination of the seeds. This was mainly due to lack of fresh seed; the supplies of locally produced seed being limited. As there are now ample quantities of fresh seed available, the difficulty of securing good germination is less pronounced. Fresh seeds, however, when planted in ordinary nursery beds, often show erratic germination and considerably improved results have been obtained both in this country and in Sumatra, by planting the seeds in open beds composed of clean sand maintained in a moist condition. By this means, and using fresh seed, it has usually been found possible to secure 50 per cent. germination within 3 to 4 months. (1)

An experiment has been conducted recently at the Experimental Plantation, Serdang, to test the effect of affording additional heat to the sand-beds by means of a glass frame. It was not found possible to use seeds from a single palm for the whole experiment. As it is probable that the seeds from different palms germinate at a different rate, the results obtained cannot be considered conclusive. It is thought, however, that the information gained is of sufficient importance to warrant early publication.

The effects of soaking oil palm seeds in hot water and diluted hydrochloric acid respectively, previous to planting in the open sand-beds, have already been published in this journal. (2) These methods of treatment, however, did not result in any marked improvement in germination and cannot therefore be recommended.

A number of methods undertaken in Sumatra, with the object of hastening the germination of seeds by the application of additional warmth, have been described. (3) These methods showed increased germination as a result of warm and humid conditions.

In the present experiment, 2000 average freshly-cleaned seeds from several five year old palms, growing at the Experimental Plantation, Serdang, were taken and divided into equal lots. One lot was planted in an open sand-bed to serve as a control while the other lot was sown in a similar position, but was covered with a glass frame. The area of sand-bed in each instance was 6 feet by 3 feet 6ins. The glass frame used was made of 'meranti'; cheap glass, measuring 10 ins. by 13 ins. a pane was employed, requiring 24 panes to glaze the frame. The price charged for making the frame was ten dollars, but this charge might be reduced slightly if a rougher frame was employed.

The following table shows the average temperatures during the month of September, 1926, at stated hours, of (a) the air in the shade, (b) the sand in the open beds, and (c) the sand under the frame.

TABLE I

Time of Day	Air in Shade °F	Open Sand-Bed °F	Sand-Bed under Frame °F
6 a.m.	73	76	80
8 a.m.	76	78	82
10 a.m.	80	86	88
12 noon	85	93	98
2 p.m.	86	95	104
4 p.m.	80	83	88
6 p.m.	78	81	84

It will be seen that the open sand-bed is somewhat warmer than the air, especially during the middle of the day, whilst the sand-bed under the frame shows a marked increase in temperature in both cases. The frame was by no means airtight and additional heat might be obtained by keeping the air within the frame quite close.

The seeds were sown in their respective beds on the 14th July, 1926. The seeds in the closed frame commenced to germinate on the 26th August, 1926, while those in the open bed, serving as a control, commenced on the 5th September, 1926. Water was given to both beds daily in equal quantities, as far as it was possible to judge.

The beds were examined weekly and those seeds that had germinated were removed. At the end of the year 1926 or exactly twenty-six weeks after sowing, the remaining seeds in both beds were lifted and examined as to their soundness.

The following table shows the rate of germination of the seeds in the closed frame and those in the open sand-bed. As already stated 1000 seeds were planted in each bed.

(1) For a full account of the details of germination of the oil palm seed, 'Jardin Botanique de Buitenzorg', Vol. 5, fasc. 2, p. 107, should be consulted.

(2) Malayan Agricultural Journal, Vol. XIV, No. 4, p. 84. (3) Investigations on Oil Palms, Rutgers, p. 28.

TABLE II.

Time from Sowing	Number of heated seeds germinated.	Number of control seeds germinated.
6 weeks	10	—
7 „	54	9
8 „	523	132
9 „	592	194
10 „	688	296
11 „	763	334
12 „	819	395
13 „	862	485
14 „	891	583
15 „	900	668
16 „	910	722
17 „	920	768
18 „	925	831
19 „	927	855
20 „	928	857
21 „	—	876
22 „	—	879
23 „	—	894
24 „	—	904

The balance of 72 heated seeds from the closed frame was lifted and examined. Of these, 50 were found to be quite dead and the remaining 22 appeared to be sound but showed no signs of germination. Of the remaining control seeds, 96 in number, 48 were dead and 48 appeared sound.

The results of germination tabulated in Table II, show considerably hastened germination in respect of the seeds in the closed frame as compared with those in the open bed. It is noticeable that whereas over 50 per cent. of the heated seeds germinated within 8 weeks from sowing, it took over 13 weeks for this to occur in the control beds. At the close of the experiment, the number of seeds which had germinated was approximately the same under the two different conditions.

The Preparation of Cigarette Wrappers from Nipah Palm.

A. E. C. Doscas.

The Nipah palm *Nipa fruticans*, which has of recent years achieved a measure of prominence as a potential source of power alcohol, has long been of considerable economic importance to the native population of countries where it thrives. The sugar obtained by tapping is esteemed as an article of food, attaps made from the leaves are probably second to none for building purposes, while cigarette wrappers also from the leaves, meet a steady but probably decreasing demand from those whose means prevent them enjoying the luxury of rice paper.

The natural stands of nipah which flourish in the Lower Perak district, have long been exploited for the preparation of cigarette wrappers. The sheets were at one time exported to Penang and there prepared, but for the past twelve years these areas have been worked by people, presumably from Penang, skilled in this particular trade, who export the article ready for consumption.

The nipah palm may bear at one time one to four leaf sheets which attain a length of usually eighteen to twenty feet before the leaflets unfold and expand, and it is these unfolded leaflets which produce the "rokok nipah".

Unexpanded leaf sheets fifteen to eighteen feet long are preferred as they produce the greatest number of leaflets in a fit condition for treatment. The sheet is cut well above the leaf stalk, leaving a number of leaflets which when expanded will be sufficient to carry on the vital processes for the maintenance of the palm. One man can usually cut and convey to his depot one hundred sheets per day.

On arrival at the depot the leaflets are severed from the mid-rib with a sharp parang, each cut removing two leaflets a short distance above the point of attachment. About seventy leaflets are thus obtained from one sheet and represent approximately half a kati of prepared material. The younger leaves at the tip of the sheet are discarded on account of their size and tenderness.

The leaflets are tied in bundles (see print 1) and, when sufficient have been obtained, each is taken separately, unfolded, and one blade is stripped from the mid-rib with a quick tearing motion of the operator's hand, and, beginning from the outside basal edge, the cuticle is separated sufficiently to allow the introduction of a finger which is quickly forced against the point of attachment completely skinning the blade. The basal end of the mid-rib of the remaining

blade is held between the teeth and treated in a similar manner, (print 2). The tips of the blades are then tied together and dried in the sun for twenty four hours during which time the material curls slightly.

After drying, the leaves are ready for export and are packed in bales of one hundred and twenty katis, the price of which fluctuates between twelve and eighteen dollars. After distribution to retailers the material is cut into suitable cigarette lengths and sold in bundles of thirty wrappers, at one cent per bundle.

Palms on State land are cut under license from the Forest department, the only restriction imposed is that sheets less than twelve feet in length shall not be cut. One palm can usually be cut three times per year but does not often yield more than one sheet per cutting. No apparent detrimental effects follow the mutilation.

The quantity of cigarette wrappers exported depends upon the prices current for wrappers and attaps, the one bringing the more remunerative return for the labour involved receiving the most attention. Both, however, cannot be produced at the same time, as immature leaves are required for wrappers and the removal of the leaves left above the leaf-stalk, which would eventually mature, would lead to the speedy death of the palm.

Plate I

Plate II

Diseases of Rice.

A fair number of enquiries have been received recently regarding Rice diseases. In Malaya, there has been no disease of Rice serious enough to warrant special attention. The literature on Diseases of Rice is very scattered, so the appearance of the following article, in which most known Rice diseases are mentioned has proved very useful. The article was entitled Pests and Diseases of Rice, by Prof. Dr. Hubert Winkler, Breslau, and appeared in "De Tropenpflanzer" Vol. 28. No. 5. Sept.—Oct. 1925. Pages 242—255.

The following is a free translation from the original German text.

Diseases of Rice.

Vegetable Pests.—Weeds, which cause more trouble to the cultivation of rice than to the cultivation of any other cereal, will not be discussed here; an exception is made for one root-parasite, belonging to the family *Scrophulariceae*

Striga lutea. Lour.—This is a green half-parasite (Halbparasit) which in Java has caused considerable damage in dry rice-fields. Of the higher parasitic plants living on tropical cultivated plants this one is probably of the greatest economic importance. It is distributed over the tropics and subtropics of the old world and in South Africa; it also causes a disease of Maize, and in India a disease of millet; in the Malay Archipelago it has been observed growing on twenty three wild grasses and on six other plants. As the seeds retain their germinating power for years when in the soil and so form a continuous danger of infection, weeding should be done before the plants are in seed.

The greater number of the parasites on rice are cryptogams (non-flowering plants).

Externally similar to "Rust" and by planters often considered to be "Rust", are the symptoms of a disease, caused by *Sclerotium Oryzae*, Catt. a species of fungus of which no fructifications are so far known. This fungus was first described by Cattaneo as a rice-pest in Nowara and Lombardy; later on it was found in Japan by Miyake and since 1912 has also been found in India. In the Philippines also stem-rot is said to occur in all rice growing districts and to cause considerable damage—(up to 34 per cent.)—which is aggravated by close planting. The disease is found in nurseries and also attacks mature plants. In mature plants the disease can be recognised by the growth of new shoots from the gradually yellowing and dying stalks and by the poor formation of the panicles which bear only a few, barren ears. If the stalk is split open, the fungus will be found at the base, the hyphae forming a dark grey network in the cavity; the

whole inner surface is covered with small black sclerotia which may develop to such an extent that the stalk is split open and the sclerotia, also formed in the intercellular spaces of the stalk, appear outside. They also occur on the inner side of the leaf-sheaths. In flooded fields the rice plants are not attacked. Control seems to be possible only by selection of immune varieties. Pereira in the Philippines found 105 out of 126 rice varieties susceptible to infection; the other ones proved to be resistant to the heaviest infection. This parasite also attacks soya beans, pepper, (Capsicum?) Sesame and a few other plants.

Apart from the above species, *Sclerotium glumale* Ces. has become known as a rice pest in Borneo and *Sclerotium irregulare* Miyake has caused slight damage in Japan. Godfrey mentions a *Sclerotium* species occurring in Louisana and Texas, which, however, seems to attack the leaves only.

Sclerotia are also formed by a fungus which formerly, owing to the similarity of its Chlamydospores to Rust spores was classed as an *Ustilago species*—(*U. Virens* Cooke)—but is known nowadays under the name *Ustilaginoidea virens* (Cooke) Takahashi (=*Usilaginoidea Oryzae* (Pat) Bref), is classed as closely related to *Claviceps purpurea*, though the cultivation of its perfect fruiting form has not yet been succesfully performed. The infected rice grain swells and turns yellowish-green. The yellowish-green smut mass steadily increases in size and soon forms a spherical, velvetty, dull-green mass, covered by the Chlamydospores; the mass in the long run becomes 6 to 10 millimeter in diameter and practically black, whilst the surface of the rice grain peels off and crumbles to dust. Under the black layer of spores of the sclerotium lies a bright orange yellow, hard layer and inside is a white, hard tissue. The disease is widely distributed in Japan and in China: up to twenty five infected grains were found on a single panicle. In the Philippines too the disease occasionally causes considerable damage; in Louisana the loss caused by it amounts to less than 1 per cent. In Sumatra it is curious to find that the occurrence of the fungus, instead of being feared, is considered to be a prophecy of a good crop, both quantitatively and qualitatively.

"Rice Blast". "Black Smut", *Tilletia horrida*, Tak. damages the grains in a different way; they are wholly or partly changed into a black spore-powder, which at the start is inside the ear-beards and often remains there; the earlets are not enlarged or deformed and it is difficult to spot them as infected. Often, however, the ear-beards spread out, liberating the spores which are round, knobby, deep brown to black and 20u to 33u in diameter. Among the spores, septate hypha can still be found. In the stalk the mycelium reaches down to 20 centimeters below the panicle. The fungus was discovered in 1898 in South Carolina, and in 1903 in

Louisana, where it also occurs on several wild grasses. It is said to have caused up to 25 per cent damage in South-Carolina, but to have been eradicated. The parasite is also widely distributed in the East-Asiatic rice growing countries; from Japan through China, Indo-China, Burma, Siam to the Malay Archipelago and British India, where, however, it is not very troublesome. As the infection takes place in the seedling stage, application of formalin or Potassium Sulphate to the seed-beds is recommended. The seedlings when taken from the nurseries may, though outwardly not recognisable as diseased, be tested by the fact that they will float in cold water. It is more effective to use a fungicidal solution, preferably of a copper compound, when making this test for selection or rejection.

Sclerospora macrospora Sacc.—for the present, seems to be of small importance; it has for the first time been discovered in Italy on maize, the male inflorescences of which take on a peculiar shade of green color in consequence of infection by the fungus. It has also been found on various other grasses. With rice, infection by this fungus also results in deformities of the panicles and earlets, causing barrenness. Yamada attributes a disease of the young plants in Japan to this fungus. They are said to decline in health immediately after transplanting in the field and to wither within 2 or 3 weeks, and considerable damage may result. This disease occurs especially frequently when the young plants in the nurseries have suffered from flooding. Yamada found the oospores of *Sclerospora macrospora* Sacc. in the diseased plants. He also advises measures of control and prevention which however I cannot quote because I am not acquainted with a review of his paper, which is written in Japanese.

Quite different accounts are given of the damage caused by *Helminthosporium Oryzae*, Breda de Hann, a widely distributed fungus; whereas not much damage is done in British India under normal conditions, in Japan the damage done is quite considerable.

Apart from the species mentioned, a few others, which probably are closely related, are held responsible for damage i.e. *Helminthosporium sigmoideum* Cav. *and Helminthosporium Macrocarpum* Grev. while *Helminthosporium maculans* Catt. of Saccardo has later been classed as a *Cladosporium*. The Japanese name for the disease is "goma hagare". It has been found over the whole of South-East-Asia, Italy, and recently also in Louisana. It may attack any part of the rice plant in any stage of its development. It occurs first in the leaves: brown spots of the size of a pinhead occur on both sides of the leaf, but chiefly on the bottom side; they increase in size and multiply quickly; there may be up to three hundred of them on a leaf: of the larger spots the centre becomes greyish. The tips of the leaves

of seedlings of two to three centimeters high become brown or blackish brown. When the stalks are infected, they become discoloured in spots, turn yellow, then pale brown, afterwards deep brown. The surface of these spots is covered with conidiophores which give it a velvetty appearance. If the stalk is infected close below the panicle, the latter bends over in a curve. Infection of the ear-beards as a rule starts at the boundary between inner and outer-beard; in the end it looks as if the beards were covered with blackish brown hairs. The disease can be transferred to a number of other grasses; the germination tubes of the conidia penetrate into the tissue of the host plant through the stomata or through the cuticle. In nature distribution chiefly takes place during wet weather; the optimum soil-temperature for infection is between 28° and 30°C.

The fungus may be controlled by disinfecting the seed and by spraying with solutions of the following chemicals Copper sulphate, calcium hypo-chlorite, formalin; also by treating the seed for ten minutes in water of 54°C after having first soaked it for a day in water of 10° to 15°C. As a preventive measure the rearing of resistant varieties has been attempted. Suyematsu (Suematu) has determined that none of 368 varieties experimented with was absolutely immune, but a number of them proved to be greatly resistant.

The English words: "blast or rotten neck" commonly used for damage done to rice plants—(occasionally also called "blight" in connection with other disease symptoms)—were first used in connection with damage done by *Piricularia Oryzae* Bri. et Cav. a fungus which of all rice parasites is certainly the most widely distributed; it is known from East Asia, South—Asia, Southern Europe and America. The symptoms of the disease are as follows:—

On the young plants, at first, brown spots with ashgrey centres, appear on the leaves; these spots grow larger until they merge; finally the whole leaf becomes brown and shrivels. If older plants are infected, spots may appear on the leaves, but they do not spread to the same extent; infection is more frequent and more virulent in the spot where the leaf spreads out from the sheath at the base of the spread-out leaf, that is to say just over the joints. Here small pale, moist spots appear which grow larger and become darker in color; they spread superficially and inwardly until finally the leaf-tissue is entirely destroyed, leaving small gaps behind.

Most frequently the upper stalk joints are attacked, especially the "neck", that particular spot where the stalk passes into the axis of the panicle. In that case, either the grains are poorly developed or the panicle, if fully grown, breaks off from the diseased neck. Often no fruit is formed at all, so that the pale empty panicles stand upright as in the

case of "straight head" resulting from attacks by the rice borer. The distribution of the fungus takes place quickly by means of three-celled spores. The damage in Louisana is said to be as much as 25 per cent of the crop. The opinion, that the susceptibility of rice for this disease is connected with the use of nitrogenous fertilisers, is very general. In South Carolina, reduction of the damage is said to have been effected by liming the soil, but extensive experiments made in Louisana have proved that there is no connection at all between the disease and any fertiliser. Control of the fungus by spraying with Bordeaux mixture is possible. Rotation of crops, entailing eradication of *Panicum Sanguinale* and other probable host plants of the fungus, seems to promise good results. Whereas, according to Copeland, there are no rice species which are immune to *Piricularia*, Sasaki has been able to find immune varieties in Japan and to determine that in the descendants immunity is dominant over susceptibility.

A Rice-Rust, *Puccinia Oryzae* was in 1914—1915 observed in Spain and in Italy; it was said to have destroyed as much as $7\frac{1}{2}$ per cent. of the crop in the right Ebro-delta.

Many species of the genus *Phyllosticta* have been described as leaf-parasites of Rice; *Ph. Japonica* Miyake from Japan, *Ph. Oryzae* (Cke et Mass) Miyake, *Ph. Miurai* Miyake, *Ph. glumarum* (Ell. et. Tr.) Sacc (=*Melanomma glumarum* Miyake) with fairly wide distribution in South Eastern Asia.

Of leaf-parasites and ear-beard parasites the following are also mentioned.

Mycosphaerella Hondai Miyake occurs in Korea on the leaves. *M. Shiraiana* Miyake, in Japan on leaves and sometimes on ear-beards; considerable damage is attributed to the latter. *Phaeosphaeria Oryzae* Miyake, on leaves and ear-beards is distributed over Japan and is the cause of the "Shirohagarebyo"—white disease)—the infected leaves gradually turn completely white without forming regular spots. Infected ear-beards first turn dark, and white afterwards; either the fruits develop only poorly or not at all and are brown. This fungus is considered dangerous in West Japan. In Java the damage caused by the caterpillar of a *Pyralide*, *Nymphula depunctalis* Guen, is called "white disease"—(Omo putih). *Metasphaeria albescens* V. Thum. on leaves and ear-beards, often causes loss in Japan. The damage starts with the formation of minute blackish brown spots, which grow longer, become yellowish brown first, and grey afterwards and may entirely destroy the leaves. *Chaetophoma Oryzae* Cav. in Italy and *Ch. glumarum* Miyake in Japan make the ear-beards pale, cover them with black mycelium and affect the formation of the fruit. *Pyrenochaeta*

Oryzae, Shirai. in Japan infects the leaves and ear-beards of rice plants growing on the lowlying heavy soils about the end of July. The leaves first become pale at the tips and afterwards turn brown completely; the damage goes down to the roots and the fruits develop incompletely.

Coniothyrium Japonicum, Miyake, which was discovered in Kagoschima, starts infecting the leaves at the tips and borders, and discolours them brown first and white afterwards. *Coniothyrium brevisporum*, Miyake. and *Coniothyrium anomalum*, Miyake. cause a similar disease in Japan as does *Coniothyrium Oryzae*, Cav. in Italy. *Sphaeronema Oryzae*, Miyake. in Japan discolors the ear-beards white. *Hendersonia Oryzae*, Miyake. is found in Japan on leaves and ear-beards causing brown spots on the latter; the damage extends also over the fruits. *Septoria longispora*, Miyake. in Japan discolors the ear-beards grey and prevents formation of fruits. *Cladosporium Oryzae*, Miyake. was found in Japan on the leaves of an experimentally grown Siam variety. *Epicoccum neglectum*, Desm. often occurs in Italy and Japan on the tips of young leaves and on ear-beards; *Epicoccum hyalopes*, Miyake is found in Japan on ear-beards. *Oospora oryzetorum*, Sacc. was found in the Philippines by Baker; at the time of ripening of the rice the fungus forms a whitish covering which spreads all over the panicle and is especially conspicuous on red and brown varieties. A species of *Napicladium* is mentioned by Rutgers as the cause of leaf spots in Java; Snowden reports the occurrence of *Helminthosporium* and of an undetermined *Leptosphaeria* species in Uganda; the latter covers the leaves with yellow brown spots making them look as if they were scorched.

In Japan a disease, caused by *Pseudomonas Oryzae*, Uyeda et Ischiyma, (Bacterium) and known as white spot disease, results in losses of crops which in places amount to 20 per cent. The borders of the leaves of the infected plants die off. The organism develops rapidly in the vascular bundles and finally prevents the ascent of water; the bacterium can enter the plant tissue through wounds only.

It is very similar to *Pseudomonas Stewartii*, E. F. Smith, which causes a bacterial disease of maize.

There are a number of fungi, probably saprophytic, which damage rice when stored in the grain. The one known for the longest time, is *Protoascus colorans* van der Wolk. from Java; this fungus discolors the rice grains yellow to orange or brown. 0.3 per cent of such grains in the rice are said to be sufficient to cause the rice to be unsaleable in the European market. A similar spot disease of the grains of rice, standing in stacks in the field or already stored, was observed a few years ago in the Southern States of the U.S.A. The farmers and the millers call it "stackburn", "stain" or

"flecking". The infected fruits, when germinating, form sclerotia, so that fields, sown with infected grain, show gaps, and even have to be sown a second time. Superficial sterilisation has proved to be ineffective against this apparently still undetermined fungus, which also causes a leaf spot disease. The modified Jensen hot-water method is effective in killing the sclerotia, the soaking in hot water for 16 hours and then immersion for 15 minutes in water of 54°C kills the fungus without impairing the germinating power of the seed.

Another spot disease of the grains is caused in California by an *Alternaria* species. The ear-beards turn brown in spots, or entirely, the grain below being yellow to brown. In Louisana the same fungus causes a disease of the germinating plants, the leaves of which become covered with small irregular, light brown spots.

In the northern provinces of Japan, especially on the shore of the Japanese Sea—(West Coast), two fungus species cause great damage to stored rice, an *Absidia* species and *Penicillium commune*. Thom. The damage is specially heavy in the centre of the heaps and diminishes towards the circumference. The disease symptoms in both cases are very similar, the infected grains lose their brightness and become covered with aerial mycelium, and a distinct smell, which becomes more noticeable with time, is produced. The grains become moist and form thick masses cemented with mycelium. The *Absidia* sp. discolors the grains reddish brown, the *Penicillium* more yellowish brown.

III. Non-parasitic Rice diseases.—A number of diseases of the rice plant have so far not been proved to be due to living organisms and are—probably correctly—attributed to the effects of unfavourable conditions of environment. If planted too closely or if the weather is gloomy for a long time, or if irrigated too much or too little, or in case of lack of iron or lime or of nitrogenous substances in the soil, the plants may become chlorotic. If the damage is due to the condition of the field, application of animal manure will probably cause an improvement. The disease known as "tip burn" is due to excess of mineral nutritive salts in the soil and seldom occurs in young plants on rich soils. A good steady flow of irrigation water might serve as a remedy. Keeping the fields completely dry when the plants are only a few inches high, causes the same phenomenon but strengthens the plants provided it is not continued too long.

More dangerous is the disease known as "straight-head" also called "rice-blight" (this name is however also used for parasitic diseases.)

Obviously this name is a collective one for similar effects due to different causes. The name of the disease indicates that the panicles during the time the grain ripens do not bend

over slightly, as is customary for nearly all rice varieties, but stand up straight, because only a few small grains have been formed. The ear-beards are crescent shaped. This phenomenon may be due to a number of different causes. Properly speaking "straight-head" is the name of a disease of this kind, which has occurred for about fifteen years in the rice fields of the southern states of the U.S.A. and from that time symptoms have often been described as characteristic—(but according to Hewitt not always so). It is said that the leaves turn a deeper green and are sometimes stiffer than usual; the root system is unusually enlarged by means of long, coarse roots, showing only a very few ramifications and root hairs; all axillary buds of the plants increase in length and after the harvest shoot from the stubble and cause a characteristic secondary growth, owing to which a few weeks after the harvest, all diseased plants in the field may be distinguished from the healthy ones. The disease occurs chiefly in new rice fields or in fields in which formerly dry crops, especially maize and beans, were grown; it hardly ever occurs in rice, grown after rice. The cause seems to be poor ventilation of the soil, especially insufficient decomposition of the plentiful organic substances in the soil. It may be prevented by postponing irrigation as long as possible until it becomes necessary to flood the land in order to kill the weeds; a fortnight later the field is then laid entirely dry again.

The disease occurring in Italy and there called "bianchetta" or "gentilomo" is said to show quite similar symptoms. The stalk bearing the panicle however is said to rot and to be easily pulled out of the top sheath. The cause, probably, is sudden decrease of temperature in the later stages of growth, owing to September rains or more likely still, hail-storms.

In case of the Italian disease called "colatura"—(atrophy)—again the panicles stand up straight; part of their inflorescence fails, the organs of the blossoms are turned into a "tuft of white threads". This phenomenon is said to be due to decrease of temperature or to hail-storms at the time of formation of the panicles; lack of nutrients in the soil or a too high nitrogen content are also said to be responsible.

The disease called "ramificazoine" which in some varieties occurs in nearly 10 per cent of the plants, causes abnormally frequent shooting of the axillary buds; the secondary shoots develop chiefly vegetatively and do not form panicles. Novelli attributes this curious growth of the rice plant to excessive percentage of available nutrients in the soil. Hail-storms, trampling or excess of water during the period of ripening can however possibly also cause this phenomenon.

The disease called "rachitismo" and studied by Novelli also is rare. It causes poor development of the stalks, shortening of the panicles and decrease of the size of the grains which are short and nearly round, white inside as rice usually is, but covered with a blackish skin and as a rule having a poorly developed embryo. The cause of this anomaly is attributed by Novelli to disturbances of the process of assimilation.

One of the longest known, most feared and probably most widely distributed diseases of rice is the one called "brusone". Since Garavaglio studied it in 1871, it has frequently been the subject of thorough investigation but even now has not been fully explained. Whereas Poli in 1921 classed "brown disease" among the "avversita patologiche" or non-parasitic diseases, Farneti in his work of the same year, published after his death, reconsiders that the evidence as to the cause of this notorious rice disease is in favour of its being genuinely parasitic. The many different phenomena of the disease have led to a great number of names for it. The fungi which are said to be connected with it, according to him, are probably for the greater part only different stages of development of one large polymorphous class, which includes *Pirricularia Oryzae*, *Pirricularia grisea*, *Helminthosporium Oryzae*, *Helminthosporium macrocarpum*, *Helminthosporium sigmoideum*, *Cladosporium* sp. and *Hormodendron* sp. In 1905 Brizi, made cultivation experiments and suggested that "brusone" disease-phenomena are caused by withholding air from the roots of rice plants growing in water of high temperature. The name obviously applies to a complex of damaging influences of quite different character which cause outwardly similar disease symptoms. The leaves develop rust-brown spots so that an infected field looks as if it had been scorched; the stalks turn black and become limp and the nodules swell —(hence the Italian name mal del nodo).

The roots become black and perish—(root rot)—. Shaw classes under the "straight head" diseases of the U.S.A. a number of diseases of rice in British India (due partly to fungi such as *Sclerotium*, *Cephalosporium*, and *Piricularia* and partly non-parasitic) and includes also "Brusone" together as a group of diseases, the cause of which we are not fully acquainted with yet, because the biochemical processes due to the activity of micro-organisms in the soil, are still insufficiently known to us.

The "fall" disease in Spain, the "imotsi" or "imostschi"

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*not included

disease in Japan (which is caused by *Dactylaria parasitans* Cav), the "tiem" or "tim" disease in Cochin China, the "gwabo" disease in Burma and perhaps also the "mentek" disease in Java are said to be identical with "brusone" disease; van der Elst classes as such even "Rust" and "Ufra". Where "brusone" is due to lack of oxygen in the soil, ventilation is recommended as also is slow speed of the irrigation water in order not to drive the oxygen liberating algae out of the soil; fertilisation with nitrogenous substances should moreover be moderate. In Italy "brusone" disease has, in later years, occurred more rarely and more mildly owing to better tilling of the soil.

The damage to rice cultivation, due to meteorological causes such as lack or excess of water, storms, cold, clouded skies, etc., cannot be more extensively discussed here.

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